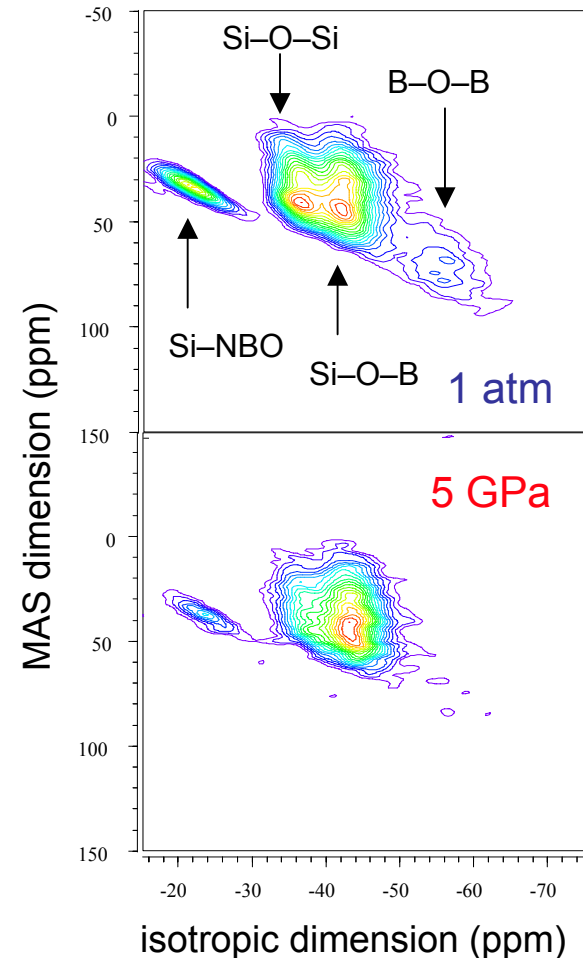


Structural Changes in Borosilicate Glasses: Analogous Effects of Pressure, Temperature, and Composition

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Borosilicate glasses are widely used in technologies ranging from computer displays to heat-resistant containers to fiber composites. Their properties are strongly affected by their short- to intermediate-scale atomic structure. The most critical structural questions are the number of oxide ions around each boron cation (either three or four), and the way that those oxide ions are linked to other cations in the glass network. We have found that temperature, composition, and for the first time, pressure, have analogous effects on the structure, confirming fundamental mechanisms that have been hypothesized for decades.

At right are shown “triple-quantum magic-angle spinning” NMR spectra for oxygen-17 in a borosilicate glasses made at ambient pressure and at 50,000 atm. The changes in the oxide ion bonding are dramatic: “non-bridging” oxygens are consumed to convert 3- to 4-coordinated boron, and other linkages re-arrange accordingly.



Pressure Effects on Glass and Melt Structure: The Materials Science/Geosciences Link

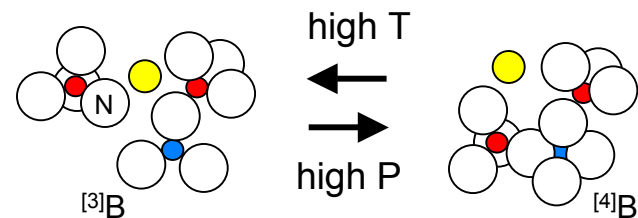
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Our group also works on the structure of melts and glasses of interest in geological processes. Recent DMR-funded discoveries of pressure effects in borosilicates point to mechanisms that are similar to those we have recently found in aluminosilicates, suggesting an important and previously unknown level of generality.

In our program, pre-and post-doctoral students from a range of disciplines (physics, chemistry, materials science, geoscience) often work together and create new scientific synergies. This discipline-crossing is also very important in broadening their perspectives and widening their career options.

The cartoon **at right** illustrates the increase in the coordination number of the network cations B and Al, allowed by the conversion of a non-bridging to a bridging oxygen. All steps in this process have been observed by NMR.

borosilicate glass melt: technology



aluminosilicate glass melt : geology

